International School of Management

Program

Project Management
725- PRMT

Preliminary Project Scope Statement

by Laurent Dorey

- June 2013 -

Robert N. McGrath, Ph.D. PMP

Project Management, Final Assignment

"Making an impact at General Motors": Preliminary Project Scope Statement

Abstract

The present Preliminary Project Scope Statement, takes its roots on the work of Robert N. McGrath (Journal of SMET Education, 1/2 august 2000), entitled "Making an Impact at General Motors", here often referred to as the "document of reference", and follows a first Project Charter, submitted by myself in May 2013, to the author. It is articulated around General Motors' Electrical Vehicle (EV) renewed program which was initiated in 1990, following the drastic state of California's Clean Air Project, due to be implemented by 1997.

Naming the well-experimented Ken Baker as the Impact EV project manager for the period 1990-1994, allowed GM to foster "probably the best (car) that GM had ever developed" while setting-up a team of experts, eager and capable of tackling the major technical issues related to coming to the markets with such a "rupture technology". It also provided GM management with enough time, to see how it's surrounding environment moved, and assess which options were best pursuing, to politically, as well as technologically and commercially, be seen as moving forward with the EVs program while not fully committing to it.

However, as often the case with large companies, and especially with one synonymous with about a century of total commitment to "internal combustion engines", both the inertia and contradictory expectations of GM's many stakeholders, led the EVs program to produce another "white elephant" project, whose conceptual promises were not matching with its market expectations. Indeed the "technological discontinuity" it offered GM to face, was quite a big leap apart from its known boundaries, yet even though Baker's and his team chose to go for a promising, yet unproven, technological external partner, the Electronic Conversion Devices (EVD) company, whom GM opted to partner with, the challenge was quite daunting and the "organization" proved itself to be having more negative effects than positive ones on the project's objectives. It required from Baker more a change leadership than a change management. He was replaced four-year within the project, by a less of a car guy, manager.

As such, the major issue highlighted by the project was the very high dependency of GM to the power system, its battery, and its criticality and impact on the due development of the overall Impact EV. Outside of its immediate compromises on autonomy and mileage, the main risk associated with it was on the contradictory market perception of the Impact and PrEView test drive program. Indeed, it forced the potential buyers, to move toward an utilitarian vision of their means of locomotion, for a high level of price and with a low level of services. As a difference with other parts of the world, consumers in the USA were targeted, yet not fully ready, while the political environment was proved, to the least, unstable and uncoordinated.

The document follows a well-defined structure, as encompassed by the Project Management Body of Knowledge (PMBOK® Guide). It aims at covering the environment of such a project, from its shape (objectives, requirements, boundaries and major deliverables), to the way this project does impact GM (organization, risks, constraints) and finally to how does the overall picture of GM environment is to have such a disruptive innovation (milestones, work breakdown structure, costs and requirements).

Introduction

In answer to California's ultra-low emissions vehicles requirements, to be put in effect already in 1997, General Motors (GM), as well as any carmakers willing to sell vehicles in the state of California past that deadline, was to reconsider its approach to Zero Emission vehicles in 1990, and come to the market with a 2% "quorum" of low emission vehicle. As such, the Electrical Vehicle (EV) concept was to be resurrected at General Motors, and a Project Management Team, led by the experienced Ken Baker, was to move forward a renewed program of innovations within the electrical car market segment. The "Impact" program assignment was born.

Indeed, already in the 1970s, a "panic response" ill-fated project of such had been run at GM, namely the GM's Electrovette program, under the leadership of the very same successful engineer, mid-level manager, Baker. Among the many reasons Baker could assess were grounds to failure of the EV at GM, were a mild commitment from top and middle Management to the program, as well as the might and "unwillingness" of a 750.000 workforce at GM, "very much devoted to the internal combustion engine", to push forward such a "disruptive innovation" (McGrath, 2012). Indeed the consequences of going for all electrical vehicles could have a global impact on the whole supply and production chain, and lead to "competing" alternative architectures, moving GM away from its roots and, at that time 90+ years old, proud history of intertwined "Big Three, Oil and Steel" developments.

As a difference with the past Electrovette program, which was a direct answer to the oil crisis of the 1970s, the Impact one can be assessed as following a set of broader non-numeric models (Project Management - MGMT627 VU p96, retrieved, June 26, 2013 from http://www.zeepedia.com). Indeed, one can see in that program, a combined operating necessity (to abide by the new Californian regulation), a competitive necessity (major worldwide players are developing EV programs) and a product line extension (EV will remain a small portion of all vehicles produced by GM for the foreseeable future, yet extends its expertise). Non-numeric projects being opposed to numeric ones where financial criteria (e.g. cash, average and internal rate of return, pay-back period and profitability, Net Present Value) are tantamount to their running. The Impact program was not expected to turn profitable "until a second or third generation EV".

As such this made Ken Baker experienced to run such a project, yet eager to get higher level of commitment and see for himself that the Impact program will move forward both for the Electrical Vehicle (EV) and for his career. After having succeeded in doing so, on both lines, Baker hand-picked a team of specialists and built in a remote corner of the GM's Tech Center, a Project Management Office (PMO). However, as per Baker's firsthand experience, as well as available literature (Aubry & Hobbs, 2011) he knew that PMO usually had a "life expectancy of about 2 years" and that the needs for change and replacement of project managers may happen along the way. In that peculiar case, it actually lasted 4 years (1994) with the naming of Bob Purcell as Ken Baker's replacement.

Objectives

According to the Project Management Body of Knowledge (PMBOK® Guide), a project is "a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates that a project has a definite beginning and end" (Project Management Institute, 2013, p553). As such the EV project was to be restarted in 1990 with the aim of matching with the new

regulations in place in California or at the least, provides GM with any respectability in running such a project (see Stakeholders). GM aimed as well as biding its time and eventually succeed in getting the legislation, and/or political game, changed once more, calling off such a drastic measure in California and in any other states closely watching. Somehow GM did not want to be seen reluctant, nor was it totally against getting a technical edge and be perceived as "knowing beyond doubts how to build fantastic (EV) automobiles", yet it wasn't betting to "make obsolete its multi-billion dollar investments in technology for the internal combustion engine". The final choice from GM Management was to go on with the development program at a slow pace though, see along the way if any synergies with either internal of external stakeholders could be found, and avoid to officially put an end date on it, keeping the project running.

As exemplified by Porter (1990) with its Diamond Model (figure 1), "the competitiveness of one company is related to the performance of other companies and other factors tied together in the value-added chain, in customer-client relation, or in a local or regional contexts". GM's Electrical Vehicle (EV) project was to be found in a broader, farther reaching, scope of interactions within and directly outside the automotive industry.

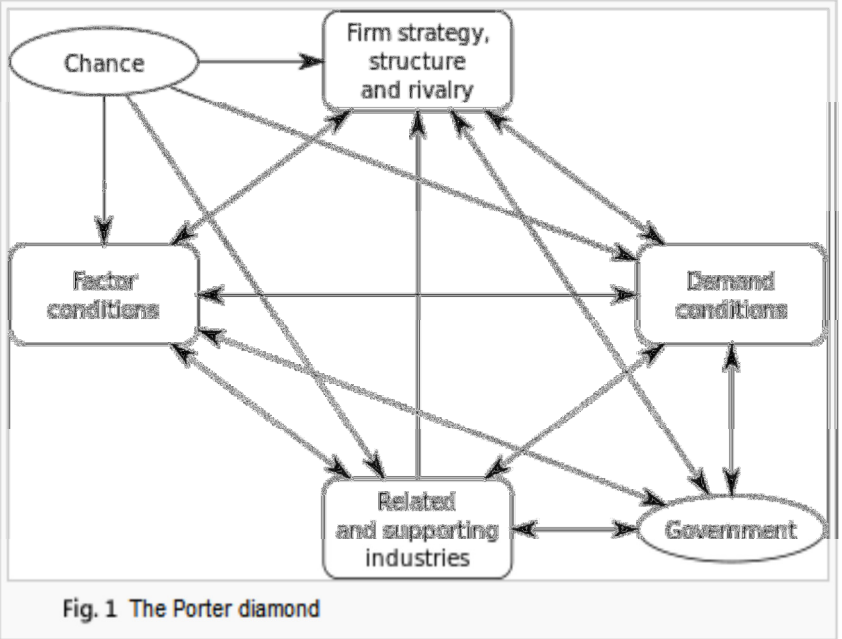

Fig. 1 The Porter diamond

Factor conditions: 750.000+ workforce, production facilities in about 150 plants, 90+ years of conceiving, manufacturing and marketing internal combustion engine cars, a total four-year investment of about $1.5 billion to EVs. Direct access (daughter companies) to former military-electronics powerhouse (Hughes Electronics) and electronics design and manufacturing facility (Delco), or to the United States Advanced Battery Consortium (USABC), whereas GM was a founding member, or externally with a close collaboration with one company called Electronic Conversion Devices (ECD).

Demand conditions: When presented to test, customers' demand for such vehicles exceeded the expectations of GM by a factor or 2.3 (Los Angeles) and 2.8 (New York), whereas surveys indicated that consumers ("early adopters") were not willing to pay a $5.000 premium for an EV, and that "two-door, two-seat, under 100-mile range" cars were not practical.

Related and supporting industries: "Mass-customization, flexible manufacturing, focused factories, limited production runs, systems engineering, small independent development programs and technological convergences with the electronic industry".

Firm strategy, structure and rivalry: Possibilities to "experiment with new ways of getting things done, new arrangements of value-adding linkages", associated with "assembling of components on a regional base, diminishing as such the capital investments, lowering consequently break-even points" on individual EVs.

Government: Clearly a key actor, at states level either for regulation (California), awaiting (Washington DC), in favor of a status-quo (Michigan) or at national level for moratorium on environmental legislation (Congress), and through its technical consortium (USABC and the Electric Power Research Institute). Confronted with intense Big Oil biased information campaigns and lobbying, it also conjointly saw global factors play more and more of a role in the "globalization dynamics".

Chance: Commitment to Ovionics technology and ECD, betting on their superior knowledge and industrialization capabilities, leading to promising supra-national licensing of the proprietary technology, at a relatively low (early) entry cost.

Requirements and characteristics

While the main focus on the EV development was to optimize the power system (battery) part, directly impacting on the mileage range of the Impact, yet indirectly playing a role in the market acceptance of such a technological gap (e.g. battery loading and reloading, exchange of components), the EV was to find its market on other key characteristics (figure 2). Indeed design of the car's body was essential in the matters of "aerodynamics, materials weight/strength, and rolling resistance" which directly translated into the body "shape" and drive system's key features, while allowing further room for computer based controlling for better comfort, reliability and safety of driving.

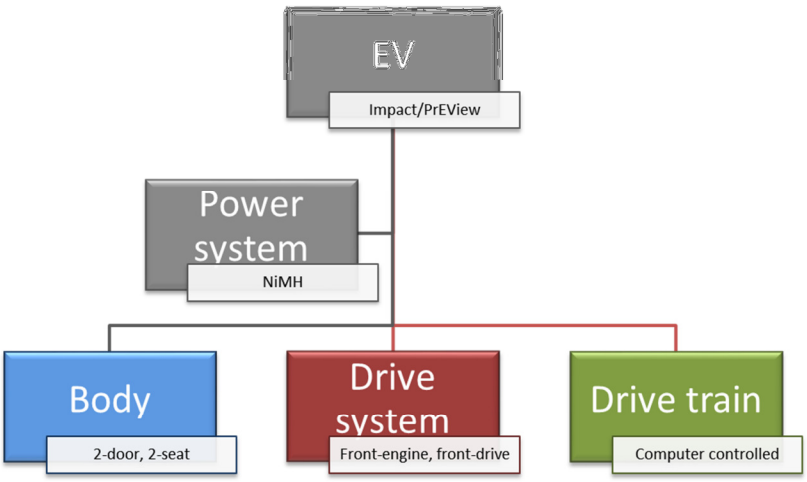

Fig. 2 Impact-EV Main Requirements and Characteristics

Yet it also translated into a "small and functional" vehicle, with a high cost of production which made it difficult to market, at least mass market it, at first.

Consequently a positive Return On Investment (ROI) was nowhere to be made in a foreseeable future, and a rough estimate of the assessed costs and expected sales within the next 4 years (post introduction), with the data available from the document of reference, showed a span of 25+ years before breaking even (figure 3). That is with a flat $150.000.000 yearly development cost, and 20.000 EV units sold a year. A growing number of sold vehicles, as well as a diminishing annual development costs level (as per more efficiency and maturity), will impact on the overall ROI, while one could consider that for a 10-year ROI to be attained, an excess of 205.000 cars will have to be sold in the following 4-year period, post launching.

	year 1	year 2	year 3	year 4	year 5	year 6	Sum
Development cost	$150 000 000	$150 000 000	$150 000 000	$150 000 000	$150 000 000	$150 000 000	$1 800 000 000
other costs	$225 000 000	$225 000 000	$225 000 000	$225 000 000			
N sold cars			20 000	20 000	20 000	20 000	80 000
Production cost			$16 500	$16 500	$16 500	$16 500	
margin per car			$3 500	$3 500	$3 500	$3 500	
Overall margin			$70 000 000	$70 000 000	$70 000 000	$70 000 000	$280 000 000
						ROI (years)	25,71
						10-year ROI	205 714 vehicles

Fig. 3 Impact Program - Return On Investment

The above mentioned costs do not take into consideration any further costs associated with the necessary infrastructure and network allowing for public and private cars' reloading, as well as any costs linked to the cars' maintenance, upgrades and repairs, as very often found with "electronics packaged in lightweight cases".

Boundaries

As such the Impact project, by its innovative nature, was bound to push GM into new direction, yet as stated by McGrath (2012), "technological innovation is important to the marketing tradition… however its impact in strategic management in this area also shows limitations…"

In the case of the EV program, it also forced GM to move into a new field (figure 4) where New Technology was to meet Existing Markets (McGrath, 2012). Adding to the technical development difficulties, having to commercialize Electrical Vehicles through an existing network of sales and maintenance partners to a customer base (consumers, corporates) willing to move forward to new energy locomotion means, while not willing to compromise on design, cost, safety and other issues (e.g. autonomy, time to reload), could prove very difficult without proper "subsidies" and "externalities".

Fig. 4 MCGrath: Innovation Management Matrix

All that offered to GM a new set of paradigm, which were difficult to match with the expectations of a large set of internal, external and peripheral stakeholders, with diverging aims, expectations and commitments to the project success, as described in figure 5.

	stakeholders	Boundaries
Internal	Top Brass	ROI, resources use and optimisation, delays and public perception
	Project Manager	ROI, resources use and optimisation, delays and internal perception
	Employees	Loss of skills, knowledge and jobs, new fields of expertise to add
	R&D	New skills and partnerships to develop, loss of expertise and recognition
	Key divisions	New skills and partnerships to develop, loss of expertise and recognition
	Plant Managers	Loss of skills, knowledge and resources. New fields of expertise to add
	Marketing/Communication	Delays and public perception, new marketing mix
peripheral	Shareholders	Investment level, ROI, Shares value, delays and public perception
	(UAW) Union	Loss of skills, knowledge and jobs. New fields of expertise to add
	Sales and repair network	Loss of skills, knowledge and jobs. New fields of expertise to add
	Current suppliers	Loss of expertise, volume of production and recognition
	New suppliers	Technological and customers' acceptance
	USABC	New skills and partnerships to develop, change of business model, Unique Selling Point
	Competitors	Loss of skills, knowledge and jobs. New fields of expertise to add. New marketing mix
external	States	Delays and public perception
	Politicians	Delays and public perception. Loss of local skills, knowledge and jobs
	Big Oil and Steel	Loss of skills, knowledge and jobs
	Consumers	Delays and public perception. Limited mileage, space, design and features

Fig 5. Impact-EV program - Stakeholders boundaries

A stakeholder being « an individual, group, or organization who may affect, be affected by, or perceive itself to be affected by a decision, activity or outcome of a project » (Project Management Institute, 2013, p563).

Major deliverables

As described before, the main deliverable (product) of the EVs program is the Impact car, allowing GM to pursue commercializing its overall range of automotive in the state of California, in the range of 98% conventional and 2% Zero Emissions ones, as of 1998, and later in the range of 90 to 10 percent (2003). As such, EVs do and will represent a niche in GM's offer (and any other carmakers) for the times to come, yet as per the weight of the state of California in the national automotive market (15 percent) and the "visibility" offered to other states by such a project (both for GM's and the state of California's benefits), GM is to propose an optimized solution, balancing its direct (internal, peripheral) and indirect (external) interests, while biding its time.

To succeed in doing so, GM decided to go for a "quasi-integration" (McGrath, 2012), as shown in figure 6, with the company called "Electronic Conversion Devices" (ECD), and its Nickel-Metal Hydride (NiMH) technology, by agreeing to a 60/40 partnership, as soon as the USABC and Team USA collapsed. They soon started running a program of test-drives (Short-Term) at GM's proving ground in Mesa, Arizona. Furthermore the alliance offered GM the unique position of getting access to a potential "breakthrough" technology, and if the solution developed was shown as being among the best for EV propulsion worldwide, its relatively low access cost, at the time of partnering, rendered the possibilities of licensing its technology quite attractive (Long-Term), synonymous with "significant profit later".

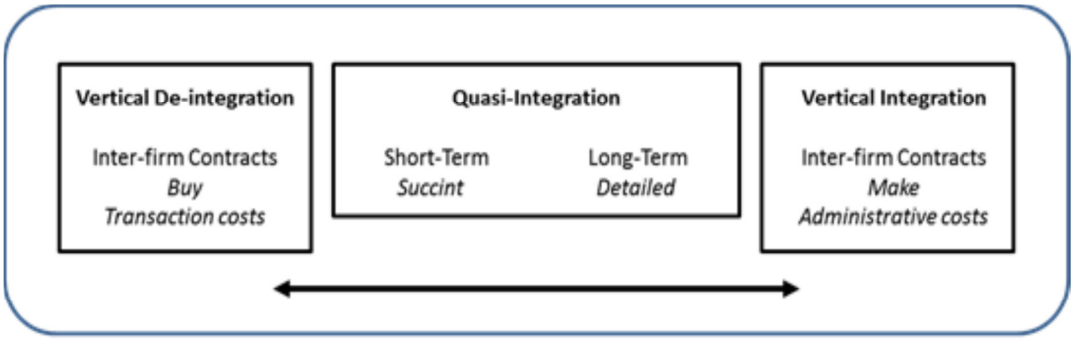

Fig. 6 MCGrath: Vertical Integration and Contracts

However, and in order for all carmakers, among them GM, to match with the "additional measures beyond the clean air act of 1990", and see the other 49 states abide by them at an affordable cost efficiency for all, a compromise on "deliverables" was offered by the auto manufacturers, whereas "car were to be sold nationwide which would be almost as clean as the low-emission vehicle now required in California". It was deemed unsatisfactory by several states and denied.

Assumptions and Constraints

On the GM internal side, among the identified issues at hands Baker could see, were that the overall Impact program lacked a full pledge commitment from GM brass. Early indications, as well as past experiences, showed Baker that GM upper management supported mildly the emergence of Electrical Vehicles, and as seen with stakeholder boundaries and major deliverables, were actually pushing the project to a sidetrack (Plan "B"), allowing keeping all options opened (e.g. stop, continuation, technological alliances and/or licensing, further cross divisions synergies), during the project life cycle, while pretending to go on, fully committed, with it.

Overall, even though Baker was given "the promise of complete backing from corporate management", it does not clearly appear that Baker did indeed manage to get a project sponsor, to "serve as an escalation path… for issues that are beyond the control of the project manager" (Project Management Institute, 2013, p32), along the different project phases. Even though backing-up was granted, GM financial woes and management committee instructed Baker to "develop a short list of feasible alternative" (which led to the establishment of four options, one of them being the Plan "B"), rendering the Impact project more like a "white elephant" than a "sacred cow". Those may be among the many reasons behind Baker's early "exit plan" agreement with GM management and his nomination as vice-president of GM's Research and Development Center, already in 1994. The latter position being a bit lesser rewarding than expected by Baker, at the time of project taking, in 1990, underlining furthermore the absence of full commitment and recognition for the Project Manager by General Motors.

On the external side, as witnessed with "external" stakeholders, the market perception of consumers was clearly favorable to EVs, but for a lack of real understanding of the necessary compromises and higher than possible expectations (e.g. "more room, wider range"). As a difference with other parts of the world, such as Asia and Europe, where "virtually no other firms were targeting the individual consumers" American carmakers, and among them GM, were having to deal in the USA with a full lack of proper infrastructure (e.g. needs for "lots of fast convenient charging facilities") to match with consumer expectations, as forcefully dictated by government and industry. As expressed by McGrath (2012), "many customers,

especially institutional ones, simply prefer stability and the avoidance of high costs of switching, to high prices", which in that case meant that a high level of expectations was to be met by an absence of a market.

Further to that, the ill-fated USABC showed that cross collaboration and cooperation was a difficult exercise among competing bodies, whether carmakers or large players, to which the political system and main actors were offering a "dramatic reversal of mood", following the mid-term November elections of 1994. Obviously, for similar yet differing reasons, other parts of the world were pushing the EV agenda encapsulating it into a nationwide "industry goal", whereas the state saw to "court relationships among (Japanese) automobile, electric utility, electronics and financial sectors, as exemplified by the Japan's ministry of International Trade and Industry (MITI).

Organization

As daunting a task as it looked, Baker could early on recognize that "the realities of his tasks frustrated a full commitment to such a vision" and that "he could not afford to try to be the sole GM agent of a rapid, traumatic, industry-wide transformation". As such, it brings to mind the difference between Change Management and Change Leadership (Kotter 2011), in the fact that "Change management … refers to a set of basic tools or structures intended to keep any change effort under control … (while) Change leadership … concerns the driving forces, visions and processes that fuel large-scale transformation." In my opinion, Baker's overwhelming task was to use the EV Impact program as the vehicle of leadership change within the organization, impacting the whole range of organizational setup at GM, from engineering, production processes, marketing and business model rolling-out. Yet the odds of seeing such a task succeed in such a relatively short time, were relatively low.

However, and further to it, Baker fairly understood that Electrical Vehicles (EV) could bring renewed flexibility, nimbleness and value-adding linkages that "many industrialists could find both threatening and exciting" within (and outside of) the GM organization. Yet, due to the history of GM, weight and might of the 750.000+ dedicated (to the internal combustion engine) workforce, and economic turmoil met in that period by GM, getting to succeed in a "complete re-invention of the automobile" within the GM group, was too "disruptive" an innovation for GM to successfully occur. Indeed as shown by Christiansen (1997), "…disruptive innovations often come from industry outsiders who in retrospect, may be better understood to have been on the outskirt of a domain rather than walled out by an industry boundary".

As such the choice for Baker to hand-pick a team of cross experts within the GM organization, once management's full confirmation of human resources availability was confirmed, and his ability to lead the team from a remote corner of GM "Tech Center" in Warren, Michigan, allowed GM the necessary room (Project Management Organization) to complete this ambitious set of project activities across the company. Later on, once the Team USA collapsed, Baker chose to reinforce collaboration with the external ECD Company around the promising Ovionics NiMH battery technology, so to secure GM's access to a "rupture technology", full of promises.

Risks

A risk is defined herein as "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives" (Project Management Institute, 2013, p. 559). On the Impact-EV program, many risks are to be associated and managed, which can be split into categories and organized in a

Risk Breakdown Structure, as show on figure 7. Before going into details, and aim at assessing their occurrence and effects, to the best of our knowledge, it should be underlined that on such a large project, covering such a large span of activities and timeframe, a lot of uncertainties will have to be dealt with along the way. As defined by Galbraith (1973), an uncertainty is defined as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organization". By essence, much information about met risks is made available along the project life cycle, and from within the organization, which consequently made their current assessments (based on the sole document of reference) a bit non-exhaustive.

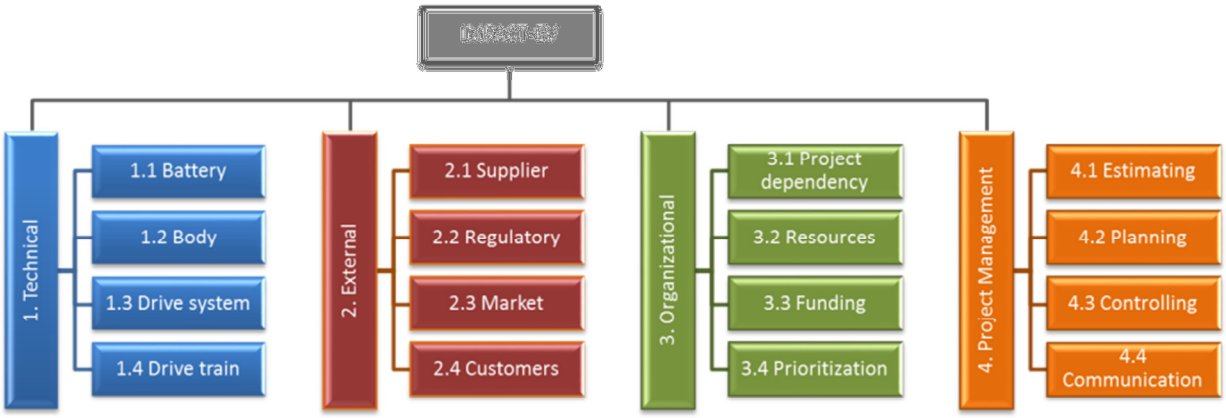

Fig. 7 Impact - Risk Breakdown Structure

On the "Technical" level, risks can be closely associated with the "requirements and characteristics" mentioned before, whereas the 4 categories can be assessed as follows:

1.1 Battery: Potential, costs and availability. The ECD solution with the NiMH battery was unproven on a large scale and uncertainties can be assessed as *very high* and *key* to the success of the Impact.

1.2 Body: Its production process, associating design, lightweight and aerodynamics were relatively new to GM, yet assessed as being *easily* manageable within a group used to manufacturability and engineering. Its effect will be positive design in the matter of efficiency, yet may appeal only to a more "utilitarian" range of car buyers.

1.3 Drive system: Cars being cars, the drive system shall be *easily* manageable by a group such as GM, and risk very *limited*.

1.4 Drive train: On the maintainability, required updates, changes and upgrade, risks may be *high* for the distribution and maintenance network to deal with so many novelties in so confined a space, if not properly trained. Risks are assessed as *high* as for the required commitment to the EV sustainability and business model.

On the "External" level, risks can be assessed as being met mainly due to the lack of deep knowledge and certainties of the market, its perceptions and evolutivity, such as:

2.1 Supplier: Indeed the battery producer, Ovionics is very much reliant on a single person, its founder, and GM was betting quite heavily on his "clues". Risks are assessed as being *very high* as for the lack of experience, absence of large scale production and unproven fully scalability of the concept.

2.2 Regulatory: Risk can be assessed as being *positive*, if the state of California, and/or the legislation (Congress) can see the needs to drop the stringency of emission standards. On the other side, risks can be seen as for carmakers to have to deal with 49+ states with different rules and requirements. On the first risk

it can be assessed as being positively *high*, while on the latter political lobbying and carmakers clout will *lower* it to a minimum acceptable level.

2.3 Market: Risk acceptance is *high*, as per the lack of "foremost" attractiveness of such a car, outside of its natural niche appeal, as compared to current markets expectations.

2.4 Customers: In addition to the above mentioned, market risk, the further lack of support infrastructure will dampen even more the openness of its market toward a broader scope of customers. It will render its encounter with them highly hypothetical and risky, in its "consumers" market segment, while solely a component of its larger scope of potential customers (e.g. private, corporate, public).

On the "Organizational" level, and as detailed in the "organization" chapter, organizational risks are very much linked to the stakeholders to be found around GM, whereas EVs are not a "natural" part of its product developments and history. As a matter of risks, the following can be assessed:

3.1 Dependency: As for the Electrovette program, the Impact-EV is very much dependent on GM reaction to an external event, as assessed above, and as such not the result of a genuine commitment to innovative rupture technology. Positive risk of dependency to external political and/or lobbying factors is deemed as *very high*.

3.2 Resources: The Impact Project Manager, Baker had secured resources in the matter of team of experts and access to external partners, yet resources can be very much dependent on the visibility and potential outcome of such a project within the GM group, which can be assessed as being *very risky*, the Impact-EV program becoming more and more of a "white elephant" type.

3.3 Funding: Even though the Impact Project Manager, Baker had secured funding for the foreseeable future of the project, the economic turmoil GM has been through during the period did lead to some adjustments and negotiations, rendering its funding *mildly secured*. However in the light of other project development, the required investments do not appear as being extraordinarily high and risk can be assessed as *low*.

3.4 Prioritization: Due to the high visibility and stringent deadline, the program had at start an initial high priority. Yet, as per the evolution of its enlarged political context, whether on a national or GM internal level, the project have moved toward a lower priority and risk of cancellation can be assessed as being *high* in the light of its lower and lower prioritization (Plan "B").

On the "Project management" level of the Impact-EV program, the leadership of its project manager, Ken Baker, makes it a well-tuned project organization with overall risks estimated as follows:

4.1 Estimating: The large experience of Baker and hand-picking of its team render the estimating risks of the Impact-EV project as being relatively *low*.

4.2 Planning: Several instances during the project life cycle have shown Baker's high capability in planning and reprogramming whether for producing prototypes, proof of concepts cars, or proof of manufacturability. This capability leaves the risk of planning as being very *low*.

4.3 Controlling: Too few information about the "Quality Function Deployment" can be assessed from the document of reference, to see how the risk of non-quality control could impact on the overall EV controlling requirements.

4.4 Communication: Highly publicized and visible, the program attracted a lot of attention, whether with the consumers, the press or the politicians, which at time went to be bigger than GM's own expectations (PrEView test drive program), and where the media were playing "conflicting signals and mixed messages" against each other. Risks of negative outcome were pondered with the positive risks of, above mentioned, dependency which at the end were assessed as being *low*, leading to the opting for a Plan "B".

All in all, as stated by Krane et al (2010), "the risk element is a long-term strategic risk when the risk element is a risk to achieve the long-term objectives of the project". In the case of GM and its Impact-EV program, the risk in the longer term will be to be outpaced by an external, new coming, more agile player which will bring to the market a truly innovative solution, unhampered by historical stakeholders, and their conservative view on the technological solution to bring the market. In other word, the highest risk being for GM to develop another "white elephant".

Milestones

A milestone is "a significant point or event in a project, program or portfolio" (Project Management Institute, 2013, p. 546). As such, and as gathered on the "making an Impact at General Motors" and associated "Teacher's notes" (McGrath, 2000), the Impact-EV program has been through a lot of intermediary steps and milestones, which figure 8 tends to summarize.

Milestone schedule

Activity identifier	Activity description	Calendar units	Project Schedule Time Frame				
			Period 1	Period 2	Period 3	Period 4	Period 5
1	California's Clean Air Project	1990	◆				
2	GM Impact-EV Project Team	1990					
3	USABC formation	1991					
4	GM Quarterly losses over $4 billions	May-1991					
5	Impact tooling-up program	1992-1993		◆			
6	Concept car built - Phase Zero	May-1992					
7	Sixteen proofs of concept cars	Mid-1992					
8	Short-list of feasible alternatives	1992					
9	Team USA concept	Jan-1993			◆		
10	Team USA split - ECD 60/40 partnership	End- 1993			◆		
11	PrEView low-volume production	Oct-1993					
12	50-EV Test cars for loan	Jan-1994					
13	Baker vice-presidency of R&D	Mar-1994					
14	Purcell nomination as new Impact program manager	Mar-1994					
15	mid-term November election	Nov-1994				◆	
16	GM quarterly record profits	Beg-1995					
17	California's legislature new 10% zero-emission mandate	Late-1995					
18	GM's Impact mass production announcement	Mid-1996					◆

Fig. 8 Impact-EV program - Main Project Milestones

Some milestones have been postponed, especially the initial plan for EV production (Mar-1993), while the California's legislature was switched to a 10 percent threshold of low-emission cars, to be in effect in 2003.

Work Breakdown Structure

A Work Breakdown Structure (WBS) is « a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables » (Project Management Institute, 2013, p567). Figure 9 shows the Impact-EV Work Breakdown Structure, incorporating as well some of the gathered "ancillary" requirements, necessary to consider at time of conception and/or launch.

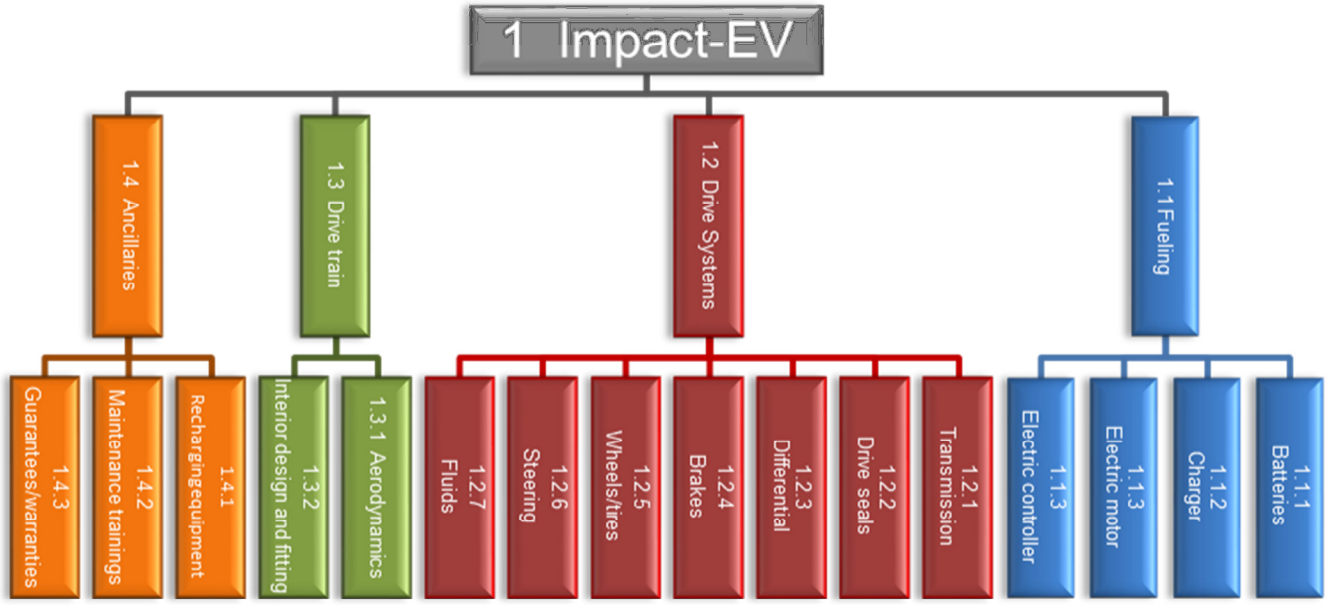

Fig. 9 Impact-EV Work Breakdown Structure

The information found in the document of reference, and their translation into the above WBS, do not allow to offer the full extent of the Impact-EV Work Breakdown Structure, as no clear indication as for costs, schedule and resource information assigned to each work package, were though made available.

Cost estimates

Cost aggregation is the « summing of the lower-level cost estimates associated with the various work packages for a given level with the project's WBS or for a given cost control account » (Project Management Institute, 2013, p534). Figure 10 shows the Impact-EV cost aggregation, as per the financial data gathered in the document of reference. Even though the costs estimates cannot be directly associated with the previously detailed Impact-EV Work Breakdown Structure (figure 9), its declination into a "Micro" and a "Macro" analysis put some perspectives on running costs and overall finanical picture of the EV program, while indications gathered around the Team USA models allow to assess how does the GM EV program do compare with other Tier-1 (American) carmakers' EV programs.

Micro analysis		
cost of development	$12 000 000	a month
cost of production first Impact	$16 500	a piece
tooling-up program	$179 000 000	1992-1993
concept car crahsing	$2 000 000	additional
hand-build concept car (16 pieces)	$450 000	a piece
PrEView test drive program	$340 000	a piece

Macro analysis		
total cost of development program	$300 000 000	
total cost of development 4-year period	$1 500 000 000	
Additional expenses	$500 000 000	
PrEView test drive program - about 100 pieces	$32 000 000	
ongoing PrEView test drive program	$235 000 000	reduced

Team USA		
Ford EcoStar	$100 000 000	
Chrysler TEVan	$145 000 000	
GM 2-door Impact	$275 000 000	
GM 4-door Impact	$335 000 000	
team USA model - conversion of existing one	$500 000 000	highest
team USA model - new design	$775 000 000	highest
team USA model - compromised options	$853 000 000	highest

Fig. 10 Electric Vehicles - Costs estimates

Configuration Management requirements

The Configuration Management System is "a subsystem of the overall project management system. It is a collection of formal documented procedures used to apply technical and administrative direction and surveillance to: identify and document the functional and physical characteristics of a product, result, service, or component; control any changes to such characteristics; record and report each change and its implementation status; and support the audit of the products, results, or components to verify conformance to requirements. It includes the documentation, tracking systems, and defined approval levels necessary for authorizing and controlling changes" (Project Management Institute, 2013, p532).

As such, and gathered in the document of reference, the Configuration Management requirements of GM for its Impact-EV program can be straightforwardly detailed, as in figure 11, down to the level 3 of key supplies, components, and parts. No clear indications are though given as for the system in place, but GM large history and experience in such configuration management and car making, allow to believe that each level and set of procedures is well enough formalized and documented, in such a way as to provide management with enough information to evaluate, check, assess, compare and verify conformance to beforehand agreed requirements.

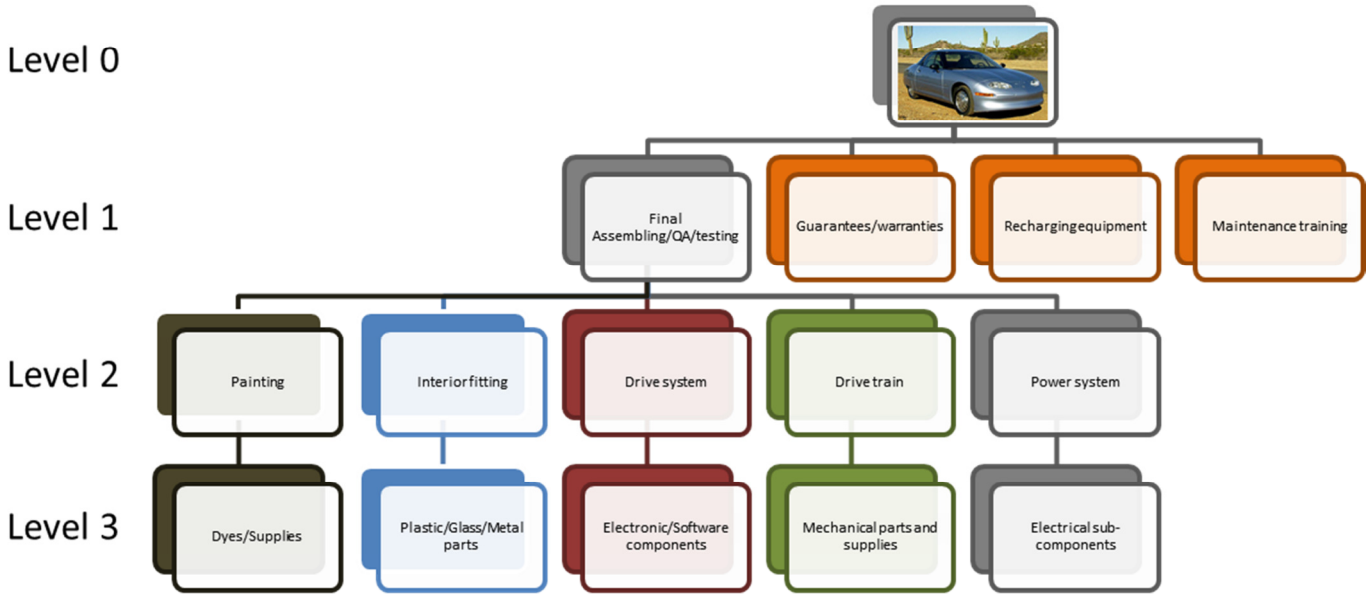

Fig. 11 Impact-EV Configuration Management

Along the evolution of the program, one can assess that the concurring technical choices and commitments, as made by the project team (and sub-level entities) under the leadership of the Project Manager and his lieutenants (as shown at the time of the "fast build effort"), allowed for product evolution (technical and/or commercial led) and relative flexibility. It provided as well indication for further opportunities for improvements and cross level communication.

Approval requirements

In order to proceed further with the project development, a Program Evaluation and Review Technique (PERT) may be implemented, as illustrated in figure 12. A PERT diagram is "a technique for estimating that applies a weighted average of optimistic, pessimistic, and most likely estimates when there is uncertainty with the individual activity estimates" (Project Management Institute, 2013, p553). Even though information about estimates are absent from the document of reference, it can clearly be assessed that the most critical component (or group of) is represented by the power system (battery) which at turns impacts on the overall car design, and especially its drive train conception, which will in turn impact on the requirements for recharging (loading facilities), prior to delivering a finished "product".

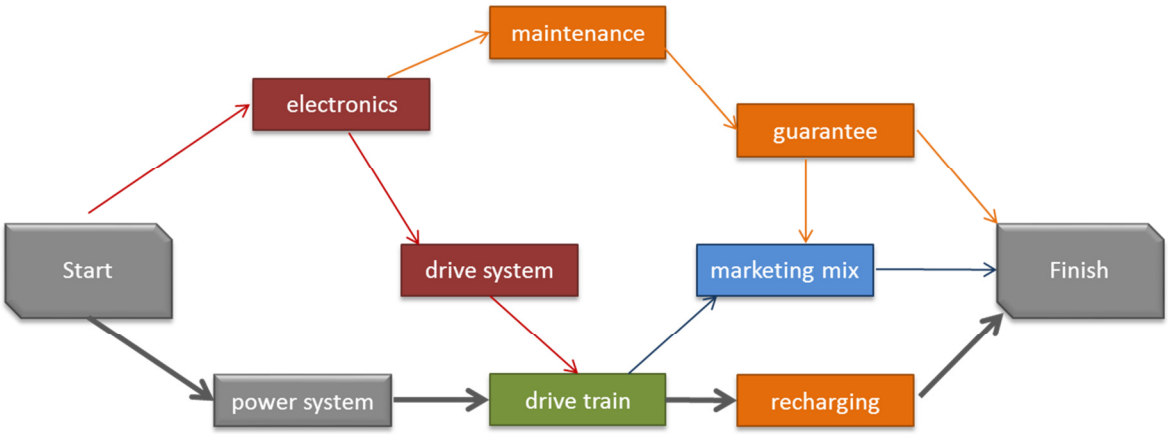

Fig. 12 Impact-EV PERT Diagram

Consequently a delay in its finalization will lead to an overall postponement of the finished product availability, which will define it as the project's critical path. Alternatively the other estimates and intermediary approval requirement steps, will be defined as the project scope creeps, in such a way that their lengthening will not impact the overall duration of the project in its critical aspect.

Conclusion

By mid-1994, Rob Purcell replaced Ken Baker as the Impact-EV project manager, with a different mission in mind, being less of a car guy. By the end of the same year, mid-term election "reversed the mood dramatically", while by the first Quarter of the year 1995, GM broke new record profits. At the end of this very same year, the low emission legislature was postponed to 2003 by the state of California. Within a scope of eighteen months, the situation at, and around, GM changed completely, while staying to the least "unstable", leaving the Impact-EV program under better (financial) lights on one side, while deemed "less necessary" (regulations wise) on the other side, surrendering the decision to emphasize for more Electrical Vehicles, at the sole determination of GM's management and stakeholders. Sticking to the chosen "Plan B", allowed continued development of production version of the Impact, while the PrEView test drive program kept going as a kind of best kept secret. To that GM and its management could go on benefiting, if not technically, at least in the PR environmental world of "innovative developments".

As defined by Tushman and Anderson (1986), the emergence of requirements for low-emission vehicles, in their EVs translation, sparkled "competence-destroying innovations... (where) … large, well-established organizations with too much inertia to adopt the new innovations suffer and lose their dominance." The EVs program at GM, and other big three players in the USA led to such an inertia, which recent history had proved true, which opened the door to new comers (e.g. Tesla of USA) and/or more eager ones (e.g. Toyota or Nissan of Japan), which took the chance of "EV/Hybrid" opportunities to shape their "structure (as to) follows strategy" (Chandler, 1962).

The "technological discontinuity", defined by McGrath (2012), and illustrated below (figure 13), "occurring when development efforts switch from one technology S-curve to a newer technology and its different technology S-curve", proved "near fatal" to GM.

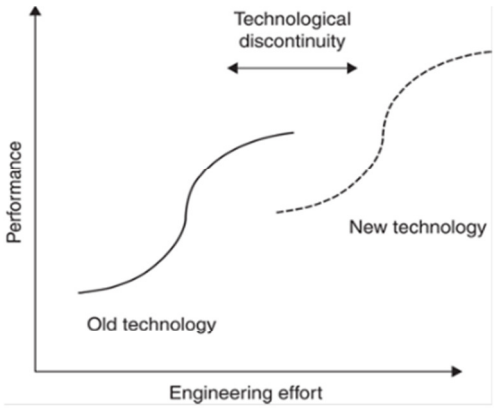

Fig. 13 Technological Discontinuity

As such GM, and any other auto manufacturer for that matter, faced a gap (discontinuity) in their technological expertise which have had, and will have, quite a large scope of repercussions. The new technology will impact, almost every of GM activities, from the way the company is to pursue conceiving, manufacturing, assembling, testing and marketing automotive, as well as the way its market is prone to react to a more "utilitarian" offer. As implied by Chandler (1962), it may mean for GM that drastic change is needed and a genuine commitment to an Electrical Vehicle strategy required, once and for all… and consequent adaptation of its structure to it, deemed sacralized.

References

Aubry, M., & Hobbs, B., 2011. *A Fresh Look at the Contribution of Project Management to Organizational Performance.* Project Management Journal. DOI: 10.1002/pmj. P4.

Christensen, C.M., 1997. *The innovator's dilemma.* Cambridge, MA: Harvard Business School Press.

Chandler, A., 1962. *Strategy and structure: Chapters in the history of the American industrial experience.* Cambridge, MA: MIT Press. Retrieved

Galbraith, J. R., 1973. *Designing Complex Organization*, ISBN:0201025590.

Kotter, J., 2011. *Change Management vs. Change Leadership - What's the Difference?* Forbes online. Retrieved 12/21/11

Krane et al, 2010. *Risks in Seven Large Projects - Which Risks Do the Projects Focus On?* Project Management Journal. DOI: 10.1002/pmj Categorizing p82.

McGrath, R., 2000. *Making an Impact at General Motors.* Journal of SMET Education, 1/2 May-August 2000, p31,52.

McGrath, R., 2012. *Project Driven Technology Strategy.* Project Management Institute, ISBN 978-1-935589-57-0. P19.

McGrath, R., 2012. *Project Driven Technology Strategy.* Project Management Institute, ISBN 978-1-935589-57-0. P26.

McGrath, R., 2012. *Project Driven Technology Strategy.* Project Management Institute, ISBN 978-1-935589-57-0. P50.

McGrath, R., 2012. *Project Driven Technology Strategy.* Project Management Institute, ISBN 978-1-935589-57-0. P53.

McGrath, R., 2012. *Project Driven Technology Strategy.* Project Management Institute, ISBN 978-1-935589-57-0. P66.

McGrath, R., 2012. *Project Driven Technology Strategy.* Project Management Institute, ISBN 978-1-935589-57-0. P95.

Porter, M.E., 1990. *The competitive advantage of nations*. New York: Free Press.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p532.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p534.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p546.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p553.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p559.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p563.

Project Management Body of Knowledge (PMBOK® Guide), 2013, Project Management Institute, 5th edition, p567.

Tushman M. L. and Anderson P., 1986. *Technological discontinuities and organizational environments*. Administrative Science Quarterly, 31 439-65.